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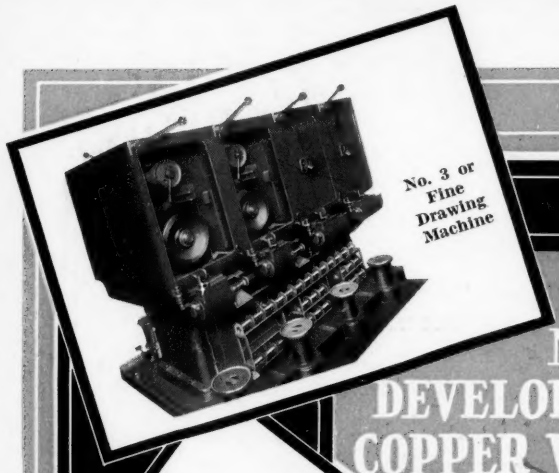
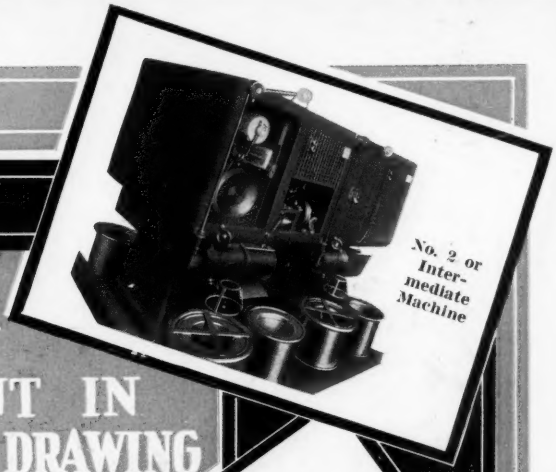


No. 3 or Fine Drawing Machine



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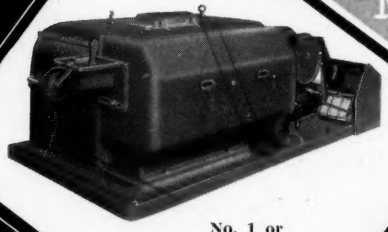
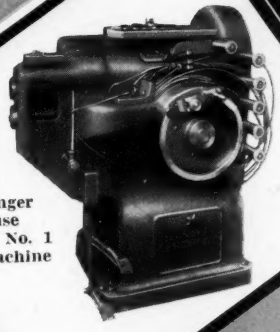


No. 1 or Heavy Type Machine with Spool Take-up



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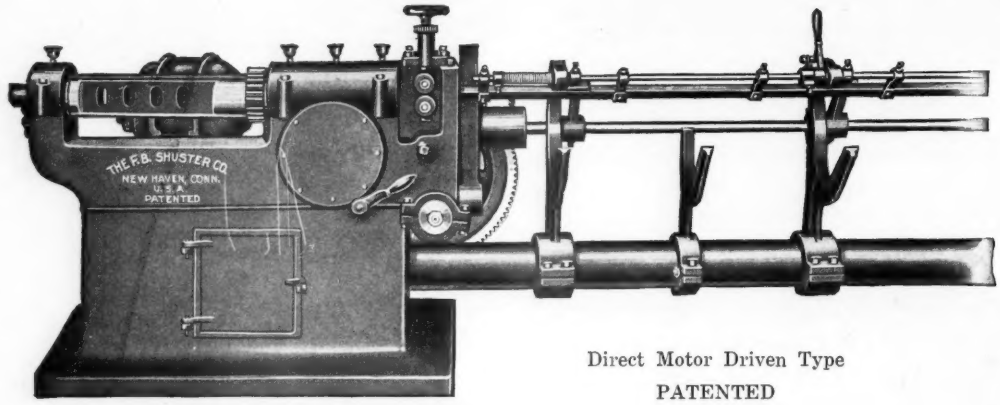

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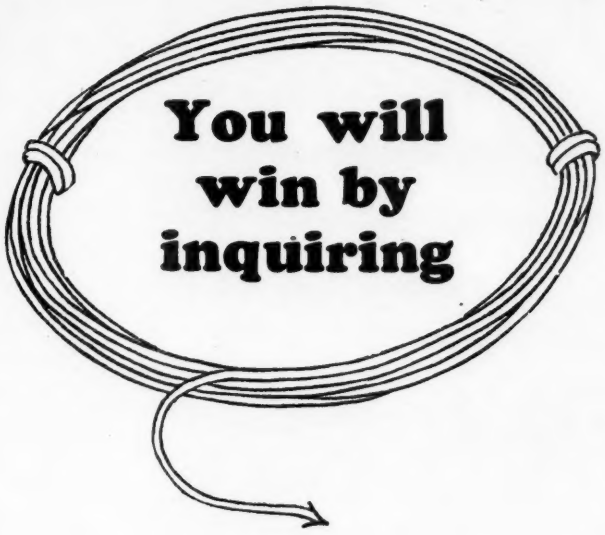

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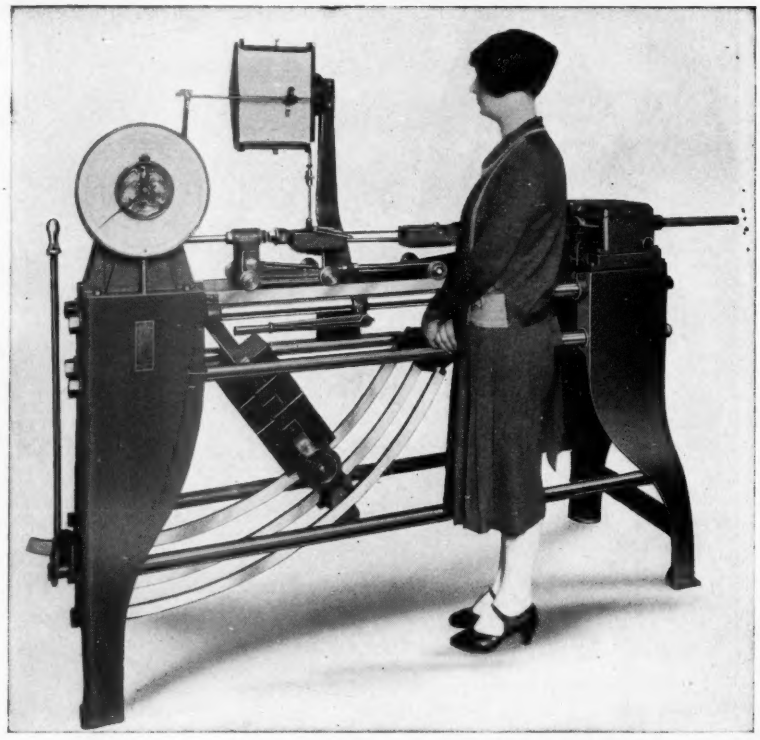

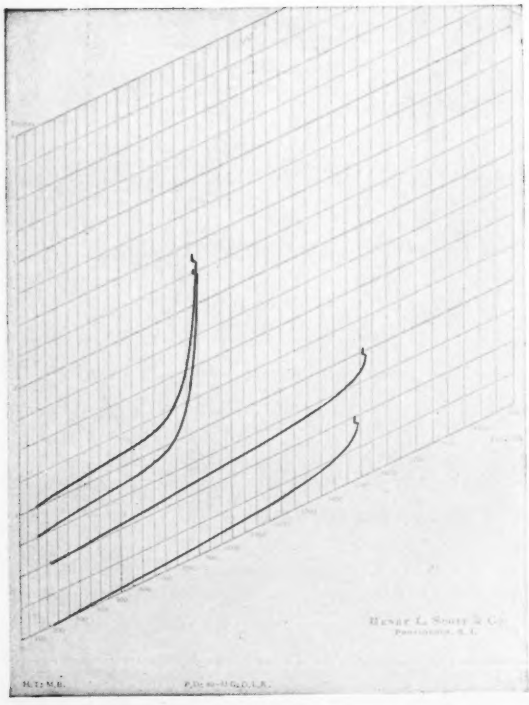

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OF course, our advertising is growing. Is it detrimental to the reading matter? On the contrary the persistent increase in advertising is an index to the steady improvement in the growth of WIRE & WIRE PRODUCTS. Advertisers contribute by far the larger portion to the magazine's upkeep and they pay on the assumption that the journal they are backing carries reading matter that is of value and interest to the public they try to reach. And we can boast of evidence that this assumption is well founded in the case of WIRE & WIRE PRODUCTS.

* * *

Some of our subtle friends ventured to hint that we dispense so much self-appreciation in this column that no praise is needed from other sources. To which we hasten to reply that our monthly enthusiasm needs no other vindication than the interest of advertisers and the daily mail of inquiries from our readers.

* * *

It is especially interesting to watch the growth of our foreign circulation. Despite the fact that two magazines dealing with wire are published in Germany, WIRE & WIRE PRODUCTS is widely read in that country as well as in France and England.

* * *

One class of our advertisers is particularly active. Foreign manufacturers display a very marked interest in bringing their product to the attention of the American industry through the medium of WIRE & WIRE PRODUCTS. Perhaps this strong foreign campaign is partly responsible for the increasing advertising by domestic manufacturers of machinery.

* * *

Recently, too, the wire drawers are realizing the important fact that a large percentage of our readers are fabricators of wire and are therefore prospective customers of the mills. A recent census of our readers gave surprising results in this respect.

The Publishers.

WIRE & WIRE PRODUCTS

A monthly publication devoted to wire drawing and wire forming

Vol. 2 March, 1927 No. 3

Contents

New Developments in Copper Wire Manufacture - - - 79
Large installation of high speed copper wire drawing machines of entirely new designs.

Relation of Annealing Temperature to Conductivity of Copper Wire, By J. C. Bradley - - - - - - - 81

Rod Cleaning and Coating, Part II, By L. D. Granger - 82
Principles of efficient pickling, baking and coating.

Preformed Wire Rope and Processed Rope Fittings, By Charles Carswell - - - 86

What's New in Wire Making, By Kenneth B. Lewis - - 88

The Alternating Torsion of Rope-wire, By Ellice M. Horsburgh 84
A discussion of rope wire characteristics based on extensive alternating torsion tests.

Editorials - - - - - - - - - - - 92

News of the Industry - - - - - - - - - 98

Review of Patents, By Eugene Grunstein - - - - 99

Patent Law for the Layman - - - - - - - - 99

Tire Chains Selected by Service Trials - - - - - 101

Buyers' Guide - - - - - - - - - - 106

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WIRE
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Vol. 2 MARCH, 1927 No. 3

New Developments in Copper Wire Manufacture

Large installation of high speed copper wire drawing machines of entirely new designs

IN 1919 engineers of the Western Electric Company's manufacturing organization were delegated to investigate the drawing of copper wire to ascertain whether this operation might be profitably carried on at the company's Hawthorne Plant in Chicago. An exhaustive study of wire drawing machinery and methods was made and the conclusion was reached that the installation of a bare wire mill with suitable machinery on the scale contemplated would result in a substantial reduction in cost of one of the company's most important raw materials. It was felt, however, that a satisfactory return on the investment could not be earned if the commercial equipment then available were used because the existing equipment did not meet all of the requirements which the engineers considered should be met in a new mill of this size and importance. Consequently, it was decided to design and build wire drawing machinery embodying such features as would insure operation at high efficiency, maximum output from small floor space and wire at the lowest possible over-all cost consistent with high quality.

Fig. 1—General view of new copper wire mill in Chicago plant. The heavy-wire machines are in the foreground.

During the next four years the engineers assigned to this work designed and built a number of experimental machines which were put into daily production to prove the principles that had been laid down. The machines were a marked departure from the conventional type and, therefore, each new feature had to be put into practice and the troubles thoroughly worked out before it could be incorporated in the final design. In 1923 the design and experimental work were completed and the construction of machinery and building begun. In January of the following year the plant as a whole was put into commercial operation and has so continued. In the meanwhile improvements in details have been made continually in order to still further reduce costs and increase production.

The mill makes nearly all of the commercial sizes on a large scale and in this respect parallels the conditions met in the commercial mill supplying wire to the trade. Obviously, a high efficiency attained under these conditions is more to the credit

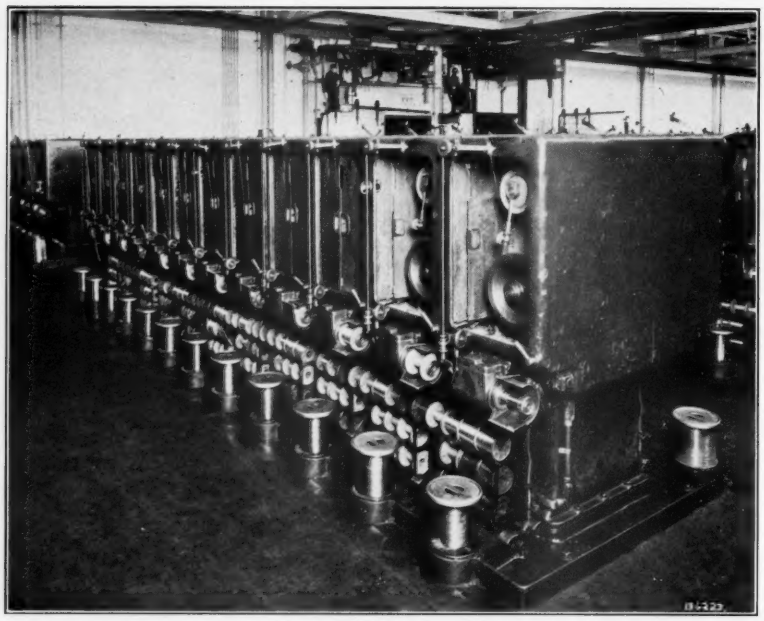


Fig. 3—No. 3 or fine-wire machines.

of the Hawthorne engineers than if the requirements were limited to one or two sizes. It is of interest to note that there have been many weeks in which production has exceeded the output as originally estimated by more than 30 per cent. Speeds have been increased from time to time and the engineers see no reason to believe that the practical limits of the machines have been reached.

The wire mill as a whole is shown in Figure 1. This view is from the end of the building nearest the rod mill and shows in succession the No. 1 (heavy wire) machines, the No. 2 (intermediate) machines and No. 3 (fine wire) machines. In all, 184 high speed heads are installed. The No. 1 machines are employed for breaking down $\frac{1}{4}°$ or $\frac{5}{16}°$ rod to the sizes from No. 6 B&S to No. 16 B&S in one operation. These are cone tandem machines whose finishing speed is 1750 ft. per minute, although some of the heads are running at 2000 ft. per minute. Die blocks for ten dies are provided. The heavier finishing sizes, of course, are produced with a lesser number of dies. The finishing speed is the same, however, regardless of the size of wire. It will be noted that the group of machines on the right of the aisle are equipped with block take-ups whereas those on the left have interchangeable spoolers carrying 240 lb. reels. Each machine is individually driven through a silent chain from a 100 H. P. motor located in the basement. The die stringers are shown immediately behind their respective wire drawing machines. Including the operating aisle between machines, the floor space occupied by one heavy unit, consisting of wire drawing machine, roll pointer and stringer and two supply swifts, is only 9 ft. by 18 ft. The machine itself occupies a space of but 5 ft. by 10 ft. 8 in.

Figure 2 illustrates a bank of No. 2 machines. These are four-head, double-sided 12-die machines finishing No. 19 to No. 30 B&S at 2500 ft. per minute. The floor space occupied by four heads is 5 ft. by 7 ft. Each head is gear driven from a 25 H. P. motor with push button control. A roll pointer and die stringer are provided for each pair of heads. Although a few machines are equipped with block take-ups, by far the greater number take up the wire on 60 lb. steel spools. It will be noted that each head when running is completely enclosed in a cabinet provided with quick-opening doors which give unobstructed access to the rolls for stringing.

The No. 3 or fine wire machines are similar in design to the intermediate type. Since the finishing sizes are from No. 31 B&S to .0025° it is necessary to use a pointer and die stringer. Consequently this machine is built with eight heads in the same floor space as that occupied by the No. 2 machine, namely, 5 ft. by 7 ft. Because of the finishing speed of 3000 ft. per minute, very high production is obtained from small floor space. The No. 3 machine takes its supply wire from the 60 lb. spools of the No. 2 machine and winds its finished wire on 5 lb. or 10 lb. spools depending on the wire size. Each eight head machine is equipped with a single 25 H. P. motor, the individual spindles being driven through clutches. An interesting feature is that the No. 2 and No. 3 machines are interchangeable as to floor space, provision being made for the cable conduit and drawing compound pipes in the same location for each machine so that they may be interchanged at will without cutting new holes through the concrete.

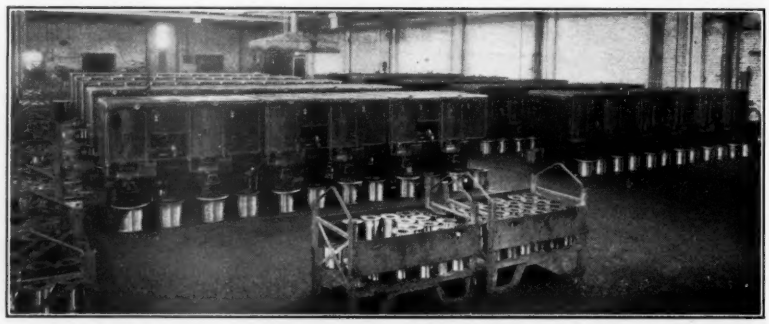


Fig. 2—A bank of No. 2 machines for copper wire of intermediate size.

From a study of the results obtained with these machines it is evident that no effort has been spared in developing machines of the highest efficiency. Every effort has been made to insure freedom from interruptions. Maintenance costs are kept down by the use of completely interchangeable unit assemblies. Ball bearings, hardened and ground parts and heat. treated gears reduce wear to a minimum. Rugged and permanent castings replace sheet metal guards and angle iron frames. Pump circulation of oil to all bearings is the rule. In fact the machines are built in accordance with the best machine tool practice. The floor space occupied is approximately one-fourth that ordinarily required for the same output, thereby effecting large savings in cost of building and ground. Thus the investment on which dividends must be earned is reduced to a minimum.

Owing to the widespread interest which this mill has aroused, the wire drawing machinery described above has been made available to the trade.

Gehret Brothers Start Wire Mill

PREPARATIONS for the manufacture of wire products in connection with their structural iron and steel business are being made by Gehret Brothers of Norristown, Pa. The machinery is being installed and large consignments of wire are being received and hauled to the building at Rambo and Depot streets, recently leased from Puleo Brothers for this purpose.

This work will be done on a machine built and patented by members of the firm and which promises to revolutionize the heavy wire weaving industry. It will weave either a square or diamond mesh.

After this section of the plant is placed in operation all wire weaving will be done on the new machines. It not only expedites the work but reduces the number of workmen formerly needed.

From Norristown (Pa.) Times Herald

Relation of Annealing Temperature To Conductivity of Copper Wire

By J. C. Bradley†

Metallurgist Amer. Brass Co.

THE relation of annealing temperature to conductivity of copper wire has been determined.[1] Conductivity hard was 98.26 per cent. After a 10-min. heating at 200° C. it was 98.69. By annealing 10 min. at 300° C. a large increase, to 100.93, occurred. Maximum conductivity, 101.15, was attained after a 500° C. anneal; thereafter it decreased to 100.53 after a 950° C. anneal. If copper is gassed the decrease is much more than this.

Material and Method

The work was done on high grade electrolytic copper, 99.942 per cent. copper plus silver, silver 0.0008 per cent. It was hot-rolled to ¼ in., then cold drawn to 0.080 in. The wire was cut into 25 5-ft. lengths and numbered 1 to 25 as cut. Four samples were tested hard. The others were wound into 5-in. diameter coils.

For the 100° C. heating a coil was put into water, the water brought to boiling, and the wire kept at this temperature for 10 min. For the higher temperatures the coils were placed in envelopes of sheet copper, a little water added, and the envelopes sealed by folding over the edges twice, and hammering them together. This kept the air out very well. The enelope and wire were brought to the desired temperature; this was maintained for 10 min., then the whole was water-quenched.

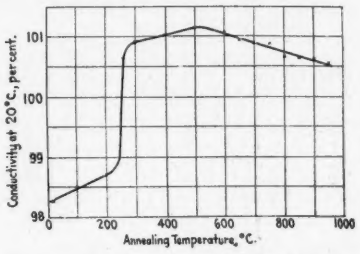


Fig. 1—Relation of Annealing Temperature to Conductivity of Copper Wire.

Results

Data from the tests are shown in the table and plot (see Fig. 1); conductivity is referred to the International Annealed Copper Standard at 20° C.

Conductivity hard is considerably less than conductivity soft. The increase is sharp

(*Contiued on page 104*)

TABLE 1.—*Annealing Temperature versus Conductivity of Copper Wire*

Sample No.	Temperature Annealed at Deg. C.	Conductivity, Per Cent.
1	20 (hard)	98.14
9	20 (hard)	98.27
17	20 (hard)	98.30
25	20 (hard)	98.31
		98.26*
11	100	98.49
2	200	98.69
12	300	100.93
13	400	101.01
14	500	101.15
4	600	101.07
6	650	100.94
15	700	100.89
16	750	100.88
22	800	100.66
5	850	100.63
7	900	100.61
8	950	100.53

*Average of the four figures above.

[1]E. S. Bardwell: The Annealing of Coldrolled Copper. Trans. (1915), 49, 755.

†Published by permission of Amer. Inst. of Min. & Metallurgy.

Rod Cleaning and Coating

Part II

Principles of efficient pickling, baking and coating drawn from the experience of some of the largest plants in the country

By L. D. Granger

Wickwire Spencer Steel Co.

THE pounds of acid required per ton of rods cleaned, vary widely with different mills.

One large company averages under 40 pounds of 60° acid, and others run as high as 70 to 80 pounds. More than this indicates poor practise under almost any conditions.

A mill buying all its rods is at the mercy of the supplier, but when a mill makes its own rods, economies are often possible by the use of water either in the reels or even further back. Low temperature finishing promotes ease in cleaning and low acid consumption.

Sources of Loss in Use of Acid

The natural result of cleaning rods in sulphuric acid is the formation of iron sulphate. The vat gradually builds up in density until the concentration of Iron Sulphate reaches a point at which cleaning becomes slower and less effective. The proper point at which to dump a tub depends upon the method of disposal of the waste acid. If a copperas plant is operated in connection with the mill, it may pay in the long run to continue cleaning until the vats contain a liquor of 28°-30° Be., altho this may be done at the cost of slowing down cleaning operations somewhat. If the mill is so fortunate as to be unrestricted in dumping waste acid into rivers or sewers, it does not pay to let the Baume exceed 25°. The question of waste acid disposal is important, and will be treated at length in other articles.

Whenever a vat is dumped, everything of course is thrown away—water, iron sulphate, and free acid—so it is important to use up as much of the acid as possible before dumping. This is generally done by arranging a schedule to dump at noon or the end of a turn, and to use for the last pin, a load of rusty rods, or some material which can be left in the acid a longer time than usual without bad effects. A general rule in many mills is that acidity at dumping must not exceed one percent. The wisdom of this from a standpoin of economy may be seen when it is considered that in a vat holding 1000 gallons, each percent of acidity represents 89.5 pounds of 66° sulphuric acid. If a crane has 4 vats, each being dumped twice a day, the very respectable amount of 716 lbs. of acid is wasted daily. If a copperas plant is operated, the free acid is utilized, of course, but at the cost of scrap for neutralization and the manufacture of a product which shows little or no profit in the end.

An article on

Inhibitors

by an authority on the subject will appear in an early issue of

WIRE & WIRE PRODUCTS

A second very serious way of throwing away money is to have leaky vats. In one mill, a campaign of education and information along this one line resulted in an actual saving of 14,480 lbs. of acid a month simply through checking the depth of solution in the vats night and morning, to determine which vats were leaking. The proper remedy was applied, leaking minimized, and the acid consumption decreased.

The usual material for the manufacturer of acid vats is cypress or pine lumber. If the vat is well designed, tie rods are provided of monel metal, copper, or some such non-corrosive metal, which can be tightened and the leaking thus stopped.

There have been some installations of late of acid proof brick set in sulphur, laid up inside a concrete shell. Reports would indicate that this construction though expensive is cheaper in the long run.

Another prolific source of waste is in the acid boiling or slopping over the edges of the vat. Certain steels cause a more violent evolution of gas upon immersion in acid than others, or a careless craneman may allow a pin to drop too rapidly into the vat. The amount of this loss is not easily calculable, but it may be avoided altogether by adding a few inches to the length of the hanger, and to the depth of the vat.

The introduction of live steam into the vat for heating the bath dilutes the solution by reason of condensed water. This is to a large degree unavoidable, as it is not feasible to heat in any other manner. Economies may be effected by replenishing waste in the cleaning vats from a hot water storage vat into which the steam from the crane is exhausted. The use of hot water from this vat also reduces greatly the time required for starting up a fresh vat. A temperature controlling device automatically shutting off the steam when the proper temperature is reached, not only saves steam and acid but prevents the bad effects of too high a temperature. The use of a Venturi type nozzle helps cleaning through maintaining circulation in vats.

Inhibitors

The action of acid in cleaning is two-fold—partly chemical through solution of the scale, but largely mechanical by forming gas bubbles under the scale and lifting it off. Left uncontrolled, the acid will continue eating away the base metal and an unduly high acid consumption will result. For this reason the cycle of operations should be carefully timed so that rods will be lifted from the bath as soon as cleaned.

In order to minimize the effect of over cleaning, various "dopes" have been introduced during the past few years whose purpose is to control fumes or inhibit the action of the acid on the bare steel. Reliable tests have shown that by the use of one of these inhibitors, the consumption of acid has been reduced 10 to 15%, a better surface produced on the wire, and a general reduction of costs secured through less off-size wire.

Control of Fumes in the Cleaning House

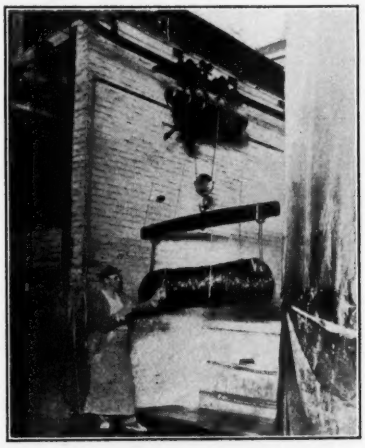
For the control of fumes there is one fundamental condition to be observed—the cleaning house must be kept warm. Several mills have so arranged ducts and flues that the warm air discharged from the bakers is blown directly into the cleaning house. If the temperature is kept at about 70°, the fumes will be invisible, and the great discomfort of the cleaner avoided. Certain addition agents, containing soapbark or even red dog flour, will increase the surface tension of the acid bath and lessen the tendency of the fumes to rise. A suction ventilating system, however perfect, will do no good, if the temperature of the cleaning house is low.

Baking

Steel possesses the marvelous but from our standpoint unfortunate, property of soaking up hydrogen gas as a sponge soaks up water. Any acid which produces hydrogen as a part of the cleaning reaction will cause steel to become brittle as a result of this "occlusion" of the gas. This action is especially noticeable in high carbon wire; patented rods and tempered wire at times becoming so thoroughly saturated that they fly to pieces in the acid vats.

This is the reason for recommending lower acid concentrations and temperatures while cleaning the high carbons. Nitric acid being an oxidizing agent will not cause brittleness, but it does produce a bad smut, and is expensive and dangerous.

The occluded gas must be removed before wire is drawn, in



order to avoid brittleness. This may be done in several ways, the more usual being to heat the rods or wire in a dry house at a temperature of preferably 350° F. By this treatment the gas is liberated and the steel returns to its normal toughness.

The gas may also be liberated by boiling the rods or wire in water for 15 to 30 minutes. This process is entirely practical, and, if sufficient space is available for the necessary tubs, reduces the time in the dry house merely to that required for evaporating the moisture from the coating and avoiding rust under the lime. There is at least one wire mill which has shut down its bakers entirely, and depends solely upon the heat in the rods to dry the lime. This is not possible with wire finer than 10, however.

It is not impossible that the wire mill of the future will have neither dry houses nor lime tubs, the baking being done in boiling water, and a soap or grease coating applied instead of lime, the lime being added to the drawing soap if it is found necessary.

As stated before, the effect of the "acid brittleness" is less marked in low carbons than in high and the relative time in the dry house is therefore proportionate. It is a peculiar fact that wire once drawn without removing the acid can not be reclaimed by further baking.

Dry houses are of almost as many types of construction as there are wire mills. It is the one piece of apparatus which seems to appeal to the individualistic side of the mind of the designer. Overhead carriers, tunnels, arms on revolving spiders, mechanically operated continuous tracks and buggies, all have desirable features, and as for methods of heating, coal vies with fuel oil, gas and electricity in accord with their availability and cost.

Regardless of design or fuel, however, provided the proper temperature is attained for the proper length of time, the rods will be in condition for drawing.

Coating

The one universal coating for dry drawing is lime. To be suited for wire drawing purposes, lime must be free from grit and foreign matter, dead burned, and free from air slacking. If it is at all possible, lime should be slacked in large quantities—a carload at a time—and allowed to season before use.

In one large plant, lime is received in bulk carload lots—thus obtaining a lower price—conveyed by an elevator to a slacking box 6′x10′x12″ deep, and slacked slowly, two men keeping it constantly stirred with hoes to prevent burning. The lime is then strained through a ten mesh screen, and stored in a bin which allows the surplus water to drain off. The resulting putty is allowed to "season" at least one week before use. This outfit is supplied in duplicate, so that one carload may be seasoning while the other is being used. The putty is wheeled to the crane in a wheelbarrow, and may be added directly to the coating tub without further treatment. The

(*Continued on page 101*)

The Alternating Torsion of Rope-wire

A discussion of rope wire characteristics based on extensive alternating torsion tests

By Ellice M. Horsburgh, M. A., D. Sc.

IN this article an attempt is made to compare various grades and sizes of rope-wire, under alternating stresses, from the point of view of resistance to fatigue. As wire cannot well be tested by rapid cycles from direct tension to compression, as by the Haig machine, the alternations given were in this case torsional. They were also comparatively slow, as the movements were made by hand. In the second place it was thought that a test would be of value which would magnify small differences between specimens apparently identical, such as successive pieces cut off the same coil. This sensitiveness to, or magnification of, small differences in new rope wire, is brought out by alternating torsions.

The laboratory work was carried out at Brunton's Wire Mills, Musselburgh. The writer desires to express his thanks to Mr. J. D. Brunton for the privilege of working in his test rooms. The machine used was of the ordinary standard type for the torsion of wire. It had a fixed and a movable headstock. A graduated scale on the bedplate enabled the movable headstock to be adjusted quickly to the required length of the specimen. The jaws which held the ends of the wire had a strong tightening device which kept the extremities fixed. Rotation of the specimen was effected by a hand wheel.

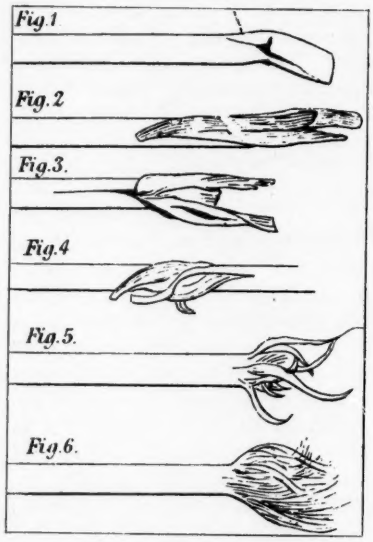
Preliminary Tests.

Preliminary tests were made on different sizes and quantities of wire to select the angle of alternating twist. One of these may be quoted as representative of others. (See Table I.)

As the tests were carried out by hand the high values of n such as occur in Nos. 1, 2, 4, 5 and 15, are inadmissible, as the operations would take too long. Most of the other values are too small for useful readings. There is one exception, No. 14, which gives suitable values for hand tests. Consequently a length of 100 diameters was chosen, with an alternating torsion of one turn, so that the angle of twist was 0.031416 radian. The complete cycle is 0, 2 pi, 0, — 2 pi, 0. This is easily given by turning the hand wheel first through one positive revolution, then through two negative revolutions, and so on. The number of complete cycles is counted.

TABLE I.—*No. of Coil C.T.* 1. *Diameter of Wire* d=0.071 *In.*

No.	Length. l.	Alternating Torsion. Turns.	No. of Cycles, n.	Result.
1	l=50 d	½+1	400	Unbroken.
2	"	"	500	Split.
3	"	1+2	1.5	Parted (flat fracture).
4	l=33.3d	½+2/3	500	No visible effect.
5	"	"	500	Slight localisation.
6	"	1+2	22	Parted (fracture at 14).
7	"	"	14	Parted (facture at 6).
8	"	"	6	Broke at grips.
9	"	"	22	Parted (long helicoidal fracture).
10	"	"	3	Parted (flat fracture).
11	"	"	5	Parted (flat fracture).
12	l=100d	2+4	1.5	Parted.
13	"	1.5+3	2	Parted.
14	"	1+2	—	Gives suitable values.
15	"	½+1	164	Parted.



Fracture of rope wire caused by alternating torsion. The various fractures, from diametral to fibrous are peculiar to various treatments of the wire.

It would not be difficult to make a machine and fit a counter to do this work automatically. In that case it would appear important to keep down the inertia of the rotating parts and then higher cycles could be used. But testing which can be carried out by muscular effort has this advantage, that the operator can feel how the material is behaving in a way that figures scarcely give, a matter not without importance.

Fatigue tests of metal are much used at the present day, and the alternations run to millions. It is quite likely, however, that the simple treatment given here will furnish suf-

TABLE II.—*Diameter of Wire*=0.071 *In. Average Breaking Load*—1,256.6 *Lb. Average Breaking Stress*=141.7 *tons per square inch. Average Direct Torsion in* 100 *Diameter*=27.8 *turns.*

No.	Localisation.	Split.	Breakdown.	Parting.	Fracture.
1	2	4	8	19	Long, flat.
2	2	16	37	71	Fibrous.
3	4	8	10	22	Long, flat.
4	3	21	85	138	Fibrous.
5	3	—	5	6	Long, flat.
6	2	—	7	11	Flat.
7	3	6	27	42	Fibrous.
8	2	5	6	8	Flat.
9	5	16	99	116	Very fibrous
10	3	11	28	53	Fibrous.
11	3	14	51	149	Very fibrous.

ficiently good comparative results for this class of wire.

At first observations were taken of the number of alternating torsions required to part the specimen. This alone was soon seen to be unsatisfactory, and it was found that four distinct stages could be noticed during the failure of the test-piece. The first stage picks out the weakest spot in the length, and its end occurs when the plastic stress is localised. This is seen by watching the specimen carefully. At the same time the loss of elasticity and the consequent yield in rotating the hand wheel are strongly marked. The next stage is the first distinct splitting of the wire. In some wires this is clear and sudden, and the test-piece opens distinctly along a diametral plane. In other cases it is difficult to detect, as the observer can hardly tell whether the crack is superficial or not. The third stage is the breakdown. This in general is very distinct, and is marked by a slight noise of fracture. The specimen, however, does not part, and the test is continued till parting occurs. This is the fourth and last stage.

The appearance of the fracture is characteristic of the material and the amount of wire-drawing. While in the ordinary torsion of rope wire the fracture is usually right, i.e., in a plane at right angles to the axis, and so does not teach us much, with alternating torsion it varies from a right fracture with a diametral split, through all stages of longitudinal splitting to extremely fibrous forms (see Figs. 1 to 6). Fig. 1 shows the right-angled fracture of a rope wire which has been softened by galvanising. Fig. 2 shows long, flat fractures which may be described as lance-like, or spear-head. In Fig. 3 the fracture is shorter, and shows just an indication of being fibrous. Such fractures are usually helicoidal. In Fig. 4 the breakdown has occurred, but parting is not complete. The fracture is helicoidal-fibrous. In Fig. 5 the fibres are long and outstanding. This might be called stranded. In Fig. 6 the fibres are very fine, and the specimen is not unlike a brush. Such a fracture might be termed hairy.

Test of a Single Coil No. C.T. 1.

As the details of many coil tests would be somewhat lengthy, only one will be given in full, and the rest will be summarized later. Take as example coil C.T. 1, already mentioned, using the standard twist No. 14. This is an exceptionally strong wire, but not necessarily a ropemakers' favourite. The figures representing number of alternations are shown in Table II.

Now the ordinary tension and torsion tests of this wire gave wonderfully uniform results, showing that the wire was really extremely uniform, while a glance at the columns in Table II shows a wide variety in the figures recorded. Here accordingly is a test whereby the minute differences in consecutive specimens from a coil are brought out, and, as one might say, magnified.

It remains now to summarise such columns of figures as those given, in order to display such tests in a brief presentable form. The statistician, with the law of errors and the definition of "precision" before him, usually takes the average of the column, forms the residuals and uses the root mean square. By the method of alternating torsions, on the other hand, the discrepancies have been emphasised as much as possible, and, from the statisticians' point of view, the root mean square treatment would be unsatisfactory. Still, however, as a means of summarising the figures, and so comparing in small space the results of tests of wires of different diameters and steels, it may be employed. Thus Table II is represented by the numbers in Table IIa.

The second line gives a number to represent the wideness of the range from the average value, produced by this magnifying method. The comparative figure for a dozen rather unfavorable direct torsions is only 1.56. This contrasts strongly with the above values for sensitiveness. Unfortunately the appearances of the fractures cannot well be summarised, though they are essentially of a fibrous form for the higher breakdown values.

Coil Tests.

A group of 15 typical coils was selected covering the usual diameters and strengths for wires of winding and hauling ropes which are required to withstand abrasion. These were tested for strength, torsion

(*Continued on page 93*)

	Localisation.	Split.	Breakdown.	Parting.
Alternating torsions—				
Average Values ..	3	11	33	38
Sensitiveness .. +	0.9	5.6	31.3	51.1

Preformed Wire Rope and Processed Rope Fittings

By Charles Carswell, M. E.

A NEW process in wire rope manufacture, said by its developers to be the first basic improvement in the art of rope making in more than a century, has recently been perfected and put into practical production by American Cable Company. The product made by the process is preformed wire rope.

The process consists in the practical application of a new principle in rope manufacture. Instead of the ordinary stranding operation, by which the separate straight wires are laid up into the rope strands, each separate wire of the rope is formed, as a preliminary operation in the stranding of the rope, to the exact shape that it must take in the completed rope. The preforming principle was conceived and the advantages of the preformed rope realized by its inventors about five years ago. Its development into practical production is the result of five years of experiment and research.

The preforming process is applied to the individual wires of each strand and to the separate strands of which the wire rope is composed. On the individual wires, preforming is accomplished in the stranding machines, and the strands are then preformed in the rope closing machines to the shape they must have in the rope. In both machines, preforming is done before the wire or strand advances to the point where the laying or twisting begins, and the process proceeds simultaneously with the laying.

A separate forming device is provided for each component element of the rope and each wire and each strand receives the same set or shape; this shaping being analogous to cold working the material. This construction makes each element the same length and results in a more perfect distribution of load stresses than was possible by any prior development of rope making.

Reduces Initial Stress

Preformed rope has a number of advantages over ordinary rope. The fact that the wires and strands are preformed and therefore maintain their shape in the rope reduces most of the initial stresses existing in the separate wires of ordinary rope, where considerable stress is required to hold the wires in place.

An example of processed rope-fitting. A sectional view shows the firm grip of the sleeve on the rope.

By thus reducing initial stress, greater useful working load is secured in the rope under operating conditions. This increased useful load capacity makes for longer life of the rope, particularly as the bending stresses are lower and fatigue does not occur as rapidly.

Among the advantages of preformed wire rope is its property of resisting unstranding. Because the wires have a permanent set in the shape of the finished rope, they will not fray out. A piece of preformed rope can be cut entirely through and the strands and wires remain in place. In case of a break on a running rope, this feature is of particular advantage. The break will always be clean, with no tangled mass of loose wires and strands to fly out into machinery and injure workmen. Safety and high salvage value are thus found in the event of a break. Similarly, broken wires in the rope lie flat in place. When the outer wires of a preformed rope break from long wear, there is no tendency for them to fray out of the rope body. They continue to fit in their place, lessening wear on the other wires and on the sheaves and drums.

Because the strands are preformed, with resulting even distribution of load, the rope has no tendency to high strand even in severe service. High stranding is one of the common causes of failure of wire rope and the avoidance of this tendency therefore is of the utmost importance in making for long life of the rope.

Resists Kinking

The permanent set of the strands and wires also enables the rope to resist kinking better than rope of ordinary construction of similar grade of material. It is therefore more "foolproof" and more resistant to many of the sources of abuse to which wire rope is often unavoidably subjected.

The ability of the strands to lie in place when the rope is cut through makes it unnecessary to seize strands for splicing. A piece of the rope can actually be unstranded and restranded again into perfect condition. No seizings are required at the ends and splicing is thus a simple problem. This advantage has permitted the development of a new type of fitting,

the processed fitting, described below.

The ease of splicing and the fact that the tendency to kink is overcome makes the use of lang lay practical with preformed wire rope. Lang lay possesses many advantages over regular lay for certain types of sheave and drum work. In Europe 80 per cent of mine cables are lang lay. In this country the inherent difficulties of splicing and handling lang lay rope of ordinary construction have largely prevented its general use. These difficulties are overcome by the new process of manufacture and lang lay rope is thus made practical for many uses.

The Processed Fitting

The fact that the preformed wire rope has no tendency to fray when cut has made it possible to develop a new type of fitting, known as a processed fitting. These processed fittings are of steel applied without zinc or heat, and they develop 100 percent of the strength of the rope. The fittings consist of steel sleeves, drilled to a diameter such that it will just slip onto the smooth, unseized end of the preformed wire rope to which the fitting is to be fastened. The sleeve is slipped into place on the end of rope and placed in a press. By pressure and hammering in this press, the steel of the sleeve is made to "cold flow" down upon the rope until it grips the wires and strands.

These processed fittings are more quickly and easily applied than the old style zinc filled socket. They are lighter, less bulky and more dependable in that they give a better equalization of the load on the strands of the rope. The fittings can be made of any reasonable length. They can be threaded or can have heads of various types. They can be furnished with eyes, yokes, etc., as required for attachment to other members, as illustrated by the accompanying cuts. They are only slightly larger in diameter than the rope to which they are attached and they permit the easy use of turnbuckles, shackles and similar equipment.

The combination of the preformed wire rope and the processed fittings is adaptable to many uses and of distinct advantage in a number of ways. Their use is said to have resulted in considerable saving in the construction of 115 coast patrol boats for the United States Government. For automobile brakes, assemblies for shock absorbers or snubbers, and other automobile accessories; for window and door control ropes; for machine tool counterweight ropes, etc., the rope and fittings are advantageous. For automobile brakes and similar uses, the rope is made with less permanent constructional stretch than most ordinary rope, and the fittings are easier to attach and adjust.

In the April issue of

WIRE & WIRE PRODUCTS

A detailed discussion of developments of wire drawing equipment including new die designs, lubrication, and pickling solutions for copper.

Increased Life

On operating ropes, such as on elevators, hoisting equipment, contractors' equipment and the like, preformed rope is said to give long life and to reduct wear on sheaves and drums. The fact that the preforming process reduces the bending stresses in the rope, as mentioned previously, is of importance in this respect. Actual field service records, some of which are reported below, show a great increase in length of service of the preformed rope over ordinary rope made of the same grade of material and of the same general type, when used on the same equipment. The performance shown by these records indicates that the preforming principle is basically sound.

Performance Records

Records of performance have been collected from a wide range of industries. On revolving shovels, preformed wire rope hoist lines ranging in sizes from ½ inch to 2 inches in diameter, have given from 50 to 200 per cent longer service than the ordinary ropes; the service records varying through the range indicated, with the types of shovels and the local digging conditions. On material haulages, ropes from ⅜ inch to 1⅝ inch diameter, handling various kinds of materials and operating in quite varying local conditions, have shown service increases of from 10 to 100 per cent for the new ropes. In logging camps, preformed ropes from ⅞ inch to 1⅜ inch diameter have been applied to various types of use and have shown from 25 to 100 percent increased service over the ordinary ropes. In the oil fields, for uses such as rotary casing lines, and sucker rod and tubing lines on machine pullers, the preformed rope has shown an increase of 25 to 100 per cent service, under varying conditions. For use on clam shell unloaders, either with crane or derrick, the new rope has given an increase of from 10 to 50 per cent, depending upon the type of bucket and the material handled. In the iron and coal industries, many shaft hoists and skip hoists using preformed rope of ¾ inch to 1¾ inch diameter have shown increases of 10 to 100 per cent service, with varying local conditions. Passenger elevator ropes usually run for long periods of time, and no service records have been reported of preformed rope worn out in this class of service. Several instances have been noted, however, where the rope is in use and has already given longer service than ordinary ropes previously used.

What's New in Wire Making

By Kenneth B. Lewis
Morgan Construction Company

WE have gradually accustomed ourselves to the fact that in most technical details relating to the fundamentals of wire drawing, we were anticipated by our ancestors by anywhere from 100 to 900 years. It will however surprise most readers to learn that some of the broader problems of wire mill administration had been freely discussed and settled several generations before Columbus sailed for America.

The so-called "vertical trust," that form of organization in which a single interest controls all steps in the conversion of a raw material to the finished article, is pretty well established in this country. It enjoys a large measure of approval and is generally believed to contribute to low cost and uniform quality. Nevertheless the vertical trust has its detractors, who point out that quality is best maintained and watchfulness stimulated by an occasional transfer to process material by purchase, holding that no interdepartmental inspection is as searching as that of a buyer.

The following petition received in the year 1435 from the members of the wire drawing craft at Coventry, England, together with the record of the action of the Mayor, is perhaps the earliest recorded voluntary dissolution of a vertical trust.

An explanation of the technical terms will perhaps help the reader.

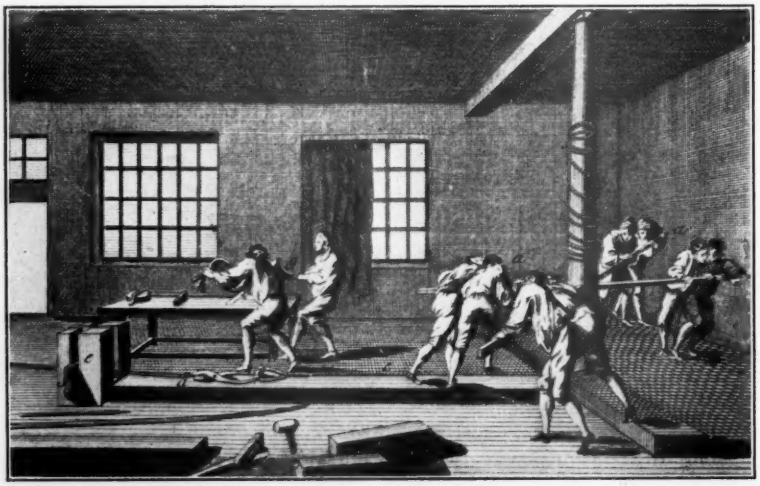
The "smythier" forged down the iron or steel billet into a wire rod probably about 5/16" in diameter and 8 or 10 feet long.

The "brakeman" did the coarse drawing by some lever device similar to a brake handle, hence our term "breaking down." Such device drew only a few inches at a stroke.

The "gurdler" was the annealer.

The "middleman" was probably the cleaner.

"Chapman" means merchant, frequently a travelling merchant or pack peddler.



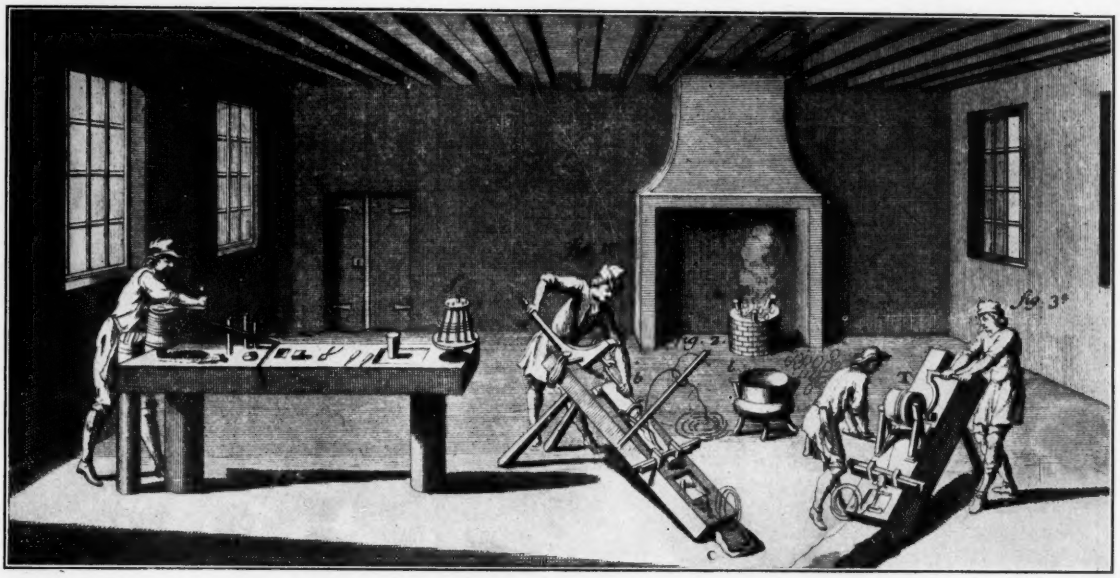
The "moto-block" in 1760. Slow start guaranteed.

The word "and" in early English frequently has the meaning of "if."

The XX li mentioned as a fine is of course 20 pounds sterling, which in view of the value of money at that time, must have loomed up like a Landis Award.

The "twin-block" in 1527.

SEPTEMBER 14, 1435. To the Reverent Mayor of the City of Coventry, and to all the worthy men of the same; for alsomuch as it is necessary and needful to every governor of a City and of Town to see such rule and governance may be had by which the king's people may be truly ruled and demeaned; be it known to you that if certain ordinances of Crafts within this City, and in Special the Craft of wiredrawers, betaken good heed to, it is like much of the king's people, and in special poor chapmen and Clothmakers in time coming shall be greatly hindered; and as it may be supposed the principal cause is like to be amongst them that have all the Craft in their own hands, that is to say, smythiers, brakemen, gurdelmen, and Cardwire drawers; for he that hath all these Crafts may, offending his conscience, do much harm. First in the smithying, if he be negligent and misrule his iron that he worketh, by unkind heats or else in other manner, the which, when it is so spoilt is not to make no manner of chapman's ware of. Nevertheless for his own ease he will come to his brakeman and say to him:—"Here is a stone of rough iron, the which must be tenderly cherished" and then the brakeman must needs do his Master's commandment and doth all that is in him; that the master supposeth will not in no wise be holpen at the girdle. Then it shall be sold for hook wire. And when it is made in hooks and should serve the fisher to take fish when it cometh to distress. Then for feebleness it also breaketh, and thus is the fisher foully deceived to his great harm. And then the wire that the master supposeth will be cherished at the girdle,



Although this picture was made about 1750 it probably represents fairly well the practise described in the text. In the center is the "brakeman" and at the left the fine-wire drawer. The "gurdle" is in the background and it seems that the "gurdler" and "middleman" are taking a turn at the block at the right.

he shall come to the girdlemen and say to him as he said to the brakeman: "Lo here is a string or two, that hath been misgoverned at the hearth my brakeman hath done his duty, I pray thee do now thine" and so doth as his master biddeth him. And then he goeth to his cardwiredrawer, and saith the same to him and he doth as his master biddeth him. And then when the cardmaker hath bought this wire thus deceivably wrought he may not know it till it come to the crooking. Then it cratcheth and fareth foul; so the cardmaker is right heavy thereof, but nevertheless he seeth because it is cut, he must needs help himself in eschewing his loss, he maketh cards thereof as well as he may. And when the cards have been sold to the Clothmaker and should be occupied, anon the teeth break and fall out, so the clothmaker is foully deceived. Wherefore, sirs, at the reverence of God in furthering of the king's true liege people and in eschewing all deceits. Weigheth this matter wisely and there as you see deceit is likely to be, thereto setteth remedy by your wise discressions. For you may right well know by experience that and the smythier and the brakeman work together and no more, and the cardwiredrawers and the middlemen together and no more. Then it were to suppose that there should not so much deceivable wire be wrought and sold as there is; for and the Craft were severed in the manner as it said above, Then the cardwiredrawers and the middlemen must needs buy the wire that they shall work of the smythiers, and if the cardwiredrawer were once or twice deceived with untrue wire he would beware and then he would say unto the smythier that he bought the wire of—"Sir, I had of you late bad wire Sir, amend your hand, or, in faith, I will no more buy of you." And when the smythier, lest he lost his customers, would make true goods; and then, with the grace of God, the Craft should amend, and the king's people be not deceived with untrue goods.

OCTOBER 3, 1435. The which bill the said Mayor at the leet held the Monday next after the feast of St. Michael thence next ensuing at Coventry, send to all the worthy men of said leet to take their advice thereupon, and there the said bill afore them was read, heard and understood; And for asmuch as the matter of this bill is grievious and Hurtful to the common people and for other grievance unto the said worthymen at the said leet shewed. They willing good ordinances and governances in this said Cite to be had in destruction of all misrules and misgoverances, the said worthymen in the said leet have ordained that from this time forward that the Journeymen of Carwire drawers and gurdlemen within the said City work in their own houses, and they have ease thereto, and not to their master's houses; and that their work be truly wrought without guile or deceit, or any colour of deceit; and that they use no Craft but that alone, upon the pain of XX li at every default to be rendered to the use of the Town wall without any grace; and that their masters constrain them non otherwise to do, upon the same pain, And also that smythiers and brakemen work to gether in their masters houses, or else there may be best served to their ease and that they work their wire of true metal and truly do thereto their labour without any deceit or Colour of deceit so that it be true Chapman's ware; and that they occupy neither cardwiredrawing nor gurdle-drawing, but only of smithing and braking, upon the pain to lose XX li at every default to be rendered to the use of the Town Wall at every default without any grace. Also that no smythier nor brakeman from this time in time to come buy nor sell be colour ne sotell Imagination, Cardwire nor Mystermannes wire the which may be hindering or grieving to the king's liege people otherwise than is ordained afore, upon the pain to lose at every default XX li to be paid as it is above said without any grace.

(*Continued on page 105*)

English Wire Industry in 1592

A petition laid before Parliment in 1592 asking that the importation of wire be prohibited throws an interesting light in the status of the industry at the time. The following is an extract from that petition:

"They are able to serve this whole Realme of England and Wales with Iron wyre sufficient and at as reasonable prices as forren wyre can be afforded for all necessary uses thereof but also with an overplus to be vented into other countries. By the said drawinge and forging of iron into wyre at Tinterne aforesaid are now mayntayned at least one hundred households, consisting of more than five hundred persons men, woomen and children that otherwise could not tell howe to bee relieved . . . and makinge of knitting needles, pack-needles, nayles, chaynes, burde caiges, mouse trappes, buckles, iron rings, and such like iron wyre wares . . . . the science of iron wyre drawings . . . being such and so easie as aged persons, woomen, children of six years

(*Continued on page 101*)

Sleeper & Hartley TRADE MARK

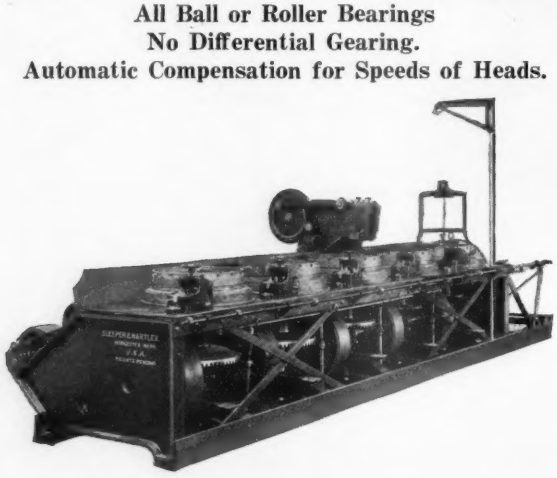
PRACTICAL CONTINUOUS WIRE

These Machines Go Into Production at Once—Ready for Delivery

Rod Frame

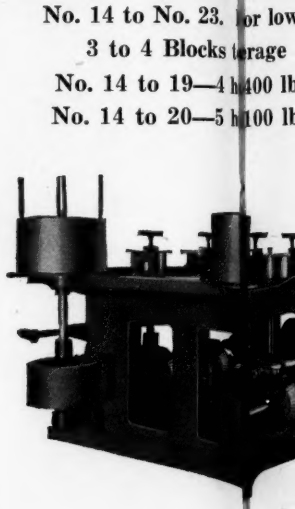
(No. 5—14 or 15 wire)
Patented June 3, 1924—May 12, 1925—others pending

All Ball or Roller Bearings
No Differential Gearing.
Automatic Compensation for Speeds of Heads.



Double 5-Drafty, I

No. 14 to No. 23. for low
3 to 4 Blocks terage
No. 14 to 19—4 h 400 lb
No. 14 to 20—5 h 100 lb



Spring Coiling Machinery

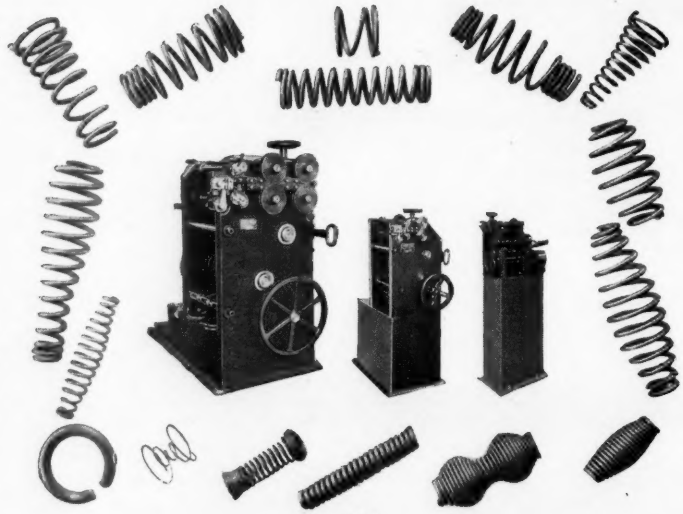
of every description.

For example, we offer:

Universal Spring Coiling Machines

in ELEVEN Sizes

handling oil-tempered wire from .004" to ⅝" diam. These machines produce spring forms as illustrated herewith at very high productive speeds.



Patented

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WORCESTER MA

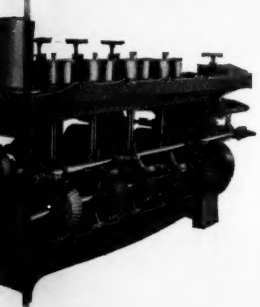
RE DRAWING MACHINERY

Sleeper & Hartley TRADE MARK

at —Reducing Overhead Increasing Production!!

...fty, Intermediate

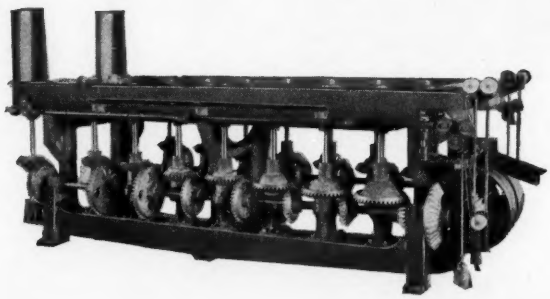
...3. ...or low carbon wire.
...s ...erage Operator.
...4 h...400 lbs. per block.
...5 h...100 lbs. per block.



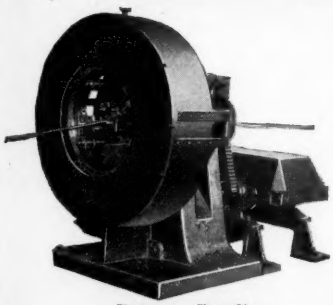
Double 8-Draft Fine Wire: Wet

No. 22 to 36. High or low carbon wire.

6 Blocks to Average Operator, 22-33, 8-hole, 660 lbs. per day of ten hours.



ARMORING MACHINES FOR "BX," PARK CABLE MOTOR WIRES, HOSE Etc., Etc.



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EDITORIAL · IMPRESSIONS

Co-Operative Competition

A FRIENDLY manufacturer of wire products recently demonstrated to us his successful application of wire to structural work heretofore accomplished by radically different means. The case is a notable instance of growth in the industry in a direction which has —as we so often remarked in these columns—been conspicuously neglected by fabricators as well as the mills. But while this growth is not accelerated as it should be, there nevertheless are sporadic extensions of the use of wire. In view of these it is important that executives realize the important implications of such extended application.

To apply wire to a use previously fulfilled by other material, means fundamentally to initiate competition. Not the competition of individuals in the wire industry, but the competition of the whole wire industry against some other industry whose product the new use of wire seeks to displace from the market.

All aggressive, deliberate effort towards increased business must be based on the appreciation of the different problems offered by these two types of competitive merchandising: the individual and the industrial.

Individual competition is static, narrow and necessarily weak being limited to the practically identical products of one industry but produced by its various members. Industrial competition, on the other hand, is dynamic because it aims at basically new markets, unlimited because the possibilities of invention are unlimited, and more severe because whole industries are here pitted against each other. The inroads of radio on the phonograph market, and sheet steel on the wood-furniture field are but two cases in point of such competition between industries.

The versatility of wire has not received its just measure of attention from fabricators. But there are signs of growing interest in the development of new applications through organized research and the encouragement of invention. Those in the van of this movement are already feeling the resistance of the competing industries, a resistance that could hardly be met by the individual manufacturer.

It is these leaders of the industry that will ultimately realize that not all business can be viewed in individual light; that the wire industry must attend to other than individual competition; that, in other words, there are problems of merchandising and distributing that are best met by the industry as a unit in competition against other industrial units.

The Engineers' Convention

We have previously had occasion to comment on the invaluable work of engineering societies in bringing new and important developments before the industry. The frequent conventions of these various societies form an important clearing house of ideas in production and management. The recent Winter Convention of the American Institute of Mining and Metallurgical Engineers offered a number of items of interest to the wire industry.

We publish elsewhere in this issue some of the important papers read at this convention, where the subject of wire has received marked attention. Not only were various problems of wire drawing competently treated but the varied fields represented by the audience made it possible to bring to bear on the special problems of wire, the technique and experience of other departments of engineering. The much discussed relation, for instance, between the annealing temperature and the conductivity of copper wire was treated in an illuminating manner by Mr. J. C. Bradley. The paper is an excellent illustration of what can be achieved by organized research in the way of coordinating the manufacturing process and the requirements of the consumer.

It is deplorable that not more of the technicians in the wire industry pursue research along these lines. The very important results presented at the Engineers' Convention should serve as a strong impetus to further study. All of these results will be published in WIRE & WIRE PRODUCTS.

In contrast to work done in England in systematic study of wire drawing and fabrication, the American industry is notably inactive. It is of course the function of an industrial journal like ours to keep a careful scrutiny of foreign literature on the subject and—as we do in the present issue—bring pertinent matter to the attention of our own readers, but we wish we had more frequent contributions of that nature from American engineers in the wire industry.

Advertising

It is well known that most large manufacturers of wire—who usually produce a large number of varied items—restrict their advertising to the institutionalized form. A good instance of a campaign along this line was discussed in a recent issue of WIRE & WIRE PRODUCTS. But it is possible for all products to be advertised with a view to direct sales and the application of this

(*Continued on page 101*)

WIRE
& WIRE PRODUCTS

Alternating Torsion of Rope Wire

(*Continued from page 85*)

and bending, and then alternating torsion tests were carried out as in Table II. The average values are shown in Table III.

Table III—Tests of Coils.

TABLE III.—*Tests of Coils.*

No.	Diameter of Wire, d".	Breaking Load, lb	Breaking Stress. Tons Sq. In.	Torsions per 100 d.	Localisation.	Split.	Breadkdown.	Parting.
1	0.078	1,066.3	99.64	37.5	20.5	32.0	39.0	50.9
2	0.080	975.0	86.6	35.8	30.0	56.2	61.0	68.5
3	0.080	1,240.0	110.1	38.4	39.2	55.2	62.6	65.8
4	0.089	1,570.0	112.7	39.7	11.8	34.2	58.2	84.0
5	0.090	1,470.0	103.2	36.5	26.4	38.0	63.3	83.3
6	0.090	1,210.0	84.9	37.8	25.7	42.8	61.7	69.8
7	0.100	1,650.0	93.8	40.5	19.4	43.8	57.2	71.0
8	0103	1,933.0	103.6	33.3	25.0	31.7	37.0	52.7
9	0.106	2,263.0	114.5	38.0	8.2	18.4	22.8	34.6
10	0.109	2,127.0	101.8	28.3	20.5	27.7	34.5	40.5
11	0.112	1,850.0	83.8	38.3	43.4	82.8	92.2	97.4
12	0.112	2,375.0	107.6	30.3	12.8	24.0	33.8	40.0
13	0.125	3,370.0	89.9	11.0	44.8	57.7	58.0	60.5
14	0127	2,863.0	100.9	32.9	15.8	47.6	71.2	112.3
15	0.128	3,370.0	116.9	33.3	22.3	34.3	35.3	40.3

The wide range of localisation values will be noted. As a rule the smaller values indicate the higher, and the greater values the lower, tensile wire. The figures for the first splitting or cracking of the wire are uncertain in some grades of material. The breakdown figures are measures of durability, but comparisons are best among wires of the same diameter, since though the angle of twist is the same before localisation in all cases, it is not constant afterwards, owing to the deformation being concentrated in the localised volume. Parting may follow immediately upon breakdown, or it may occur long afterwards. These differences mark different types of wire. In the latter case there is extreme toughness in the outer fibres, a few of which hold, and continue to twist and untwist, particularly in a long fibrous fracture.

The figures which indicate the sensitiveness to, or magnification of, small differences about the average values are given in Table IV. It will be seen that these vary widely. The $\pm$ sign is prefixed to each value.

What is the cause of heterogeneity in rope wire, as shown, though in magnified form, by Table IV? All the parts of the coil, of course, get the same treatment in the wire mill, from the preliminary stages of pickling and liming, to the concluding ones of drawing and patenting. If the material were originally uniform, a perfectly uniform wire should result. But is the rod as delivered at the mill perfectly uniform? The certain small amount of segregation which is almost impossible to avoid in the ingot, and which persists in the rod, seems to be the chief course in producing the lack of uniformity which exists. As already mentioned, however, this actual lack of uniformity is small.

TABLE IV.—*Tests of Coils. Number of Alterations Indicating Sensitiveness.*

No.	Localisation.	Split.	Breakdown.	Parting.
1	3.2	3.8	5.6	10.3
2	3.5	20.5	20.4	21.8
3	11.4	12.3	12.9	13.4
4	5.0	8.4	12.9	30.5
5	10.0	20.6	32.9	39.5
6	4.9	3.1	17.2	19.7
7	3.6	10.1	8.1	10.5
8	7.3	10.8	8.0	12.8
9	1.9	5.3	5.4	11.0
10	3.5	4.2	4.7	7.3
11	6.0	18.7	18.4	18.6
12	5.9	11.9	17.6	19.7
13	0.5	1.7	3.0	4.0
14	2.5	21.9	40.2	47.4
15	11.9	4.0	2.6	3.0

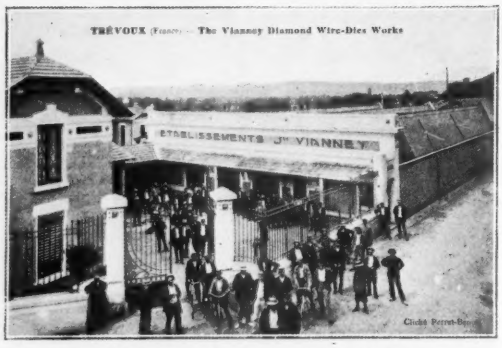
Twisting and Untwisting of Rope Wire.

It happens occasionally in an ordinary torsion test of high tensile wire, that, instead of the twist increasing uniformly all along the specimen, a torsional helical wave of acute deformation advances along the wire to the end. When this has finished, if fracture does not occur, a second wave may in the same way continue backwards till the wire has been twice traversed. Fracture then occurs.

The first effect of torsion is to elongate the wire slightly, but afterwards to shorten it. In some cases this take-up is considerable, and may amount to as much as 11 per cent. of the length. The diameter of the deformed wire is then, of course, increased. Usually, however, "takeup" is scarcely noticeable.

In torsioning some wires, especially some of the softer thick ones, the twist, as shown by the angle of the helix, is much more severe at the end of the specimen next the hand wheel. This is completely different from what is observed in a wire which is imperfectly homogeneous. The writer has seen a specimen of such a rope wire which had been torsioned to fracture, and which exhibited the helical markings merely at the place of fracture, while the rest of the specimen was scarcely strained. Such a wire is of inferior quality.

(*Continued on page 94*)



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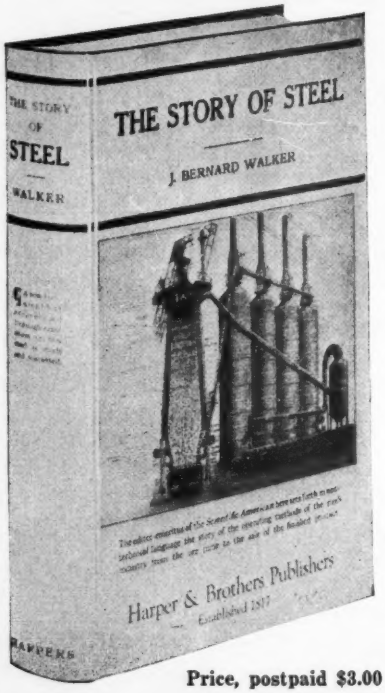

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Two books which should be in every wire mill

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A number of tests were made of a group of coils numbered M III, and others to see how much untwisting rope wire would stand after being torsioned to fracture. In most cases this was very slight, often only a fraction of a turn, because high tensile wire is much cracked at this stage.

Two curious cases, however, were observed. In one, a wire which had been twisted to death was untorsioned, and had not only all the twist taken out, but an opposite twist was actually put in up to 45 turns in 6 in. The wire turned red hot in the process. In the other the untwisting advanced as a wave along the wire, taking out the twist which had been put in. Fracture occurred before the plane of junction or discontinuity had advanced to the end of the wire. The permanent untwist in this case was 23 turns in 6.5 in. Another interesting feature was observed in some high tensile specimens which had been twisted to death. If such a specimen were bent slightly it crepitated. This was due to the combined splitting and torsion.

Cage Effect Produced in a Single Wire.

The "cage," which appears sometimes on the fracture of a wire rope, and which is spoken of in a former paper,* may be produced in a single wire, though in a simple form. A high-tension wire was torsioned to the end of the first wave belt stage already referred to. The ends of the wire were kept free from torsional deformation. This was then placed in a vertical tensile machine and broken, the unstrained ends only being held in the grips. In three cases out of four a cage was obtained.

In these the break occurred at the lower end of the torsional deformation, while the cage was formed at the upper end. The explanation is the same as when the phenomenon occurs in rope.

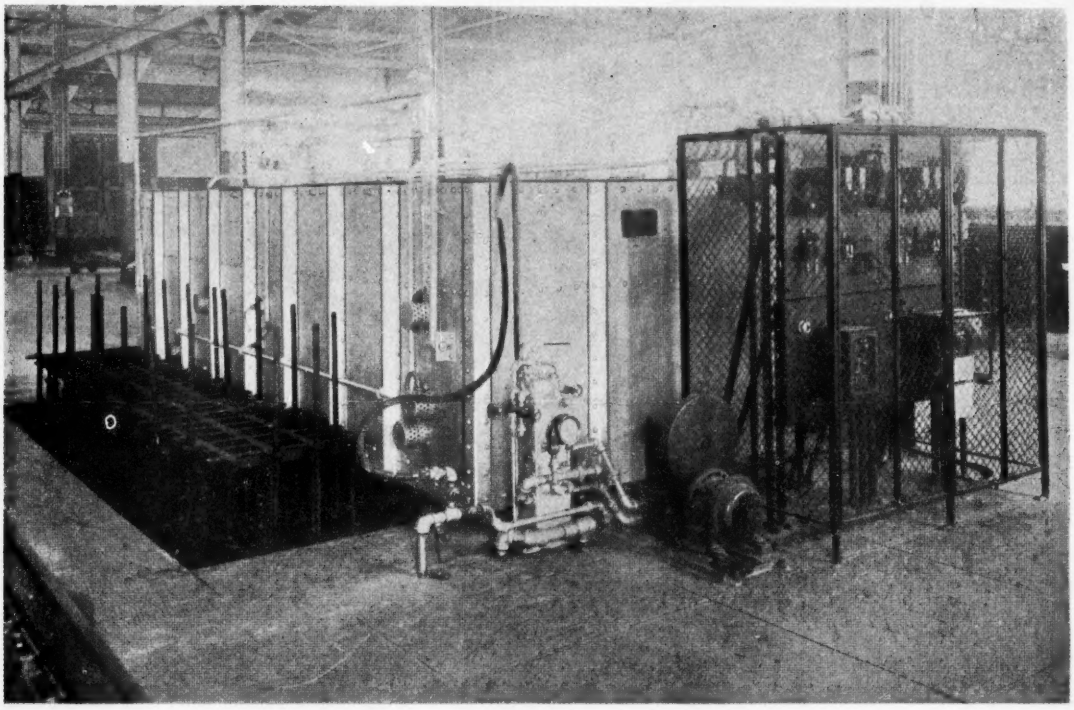
Apparent Strength of Torsioned Wire.

In a tensile test there are

(*Continued on page 96*)

*See Engineering, Vol. cxii, page 707.

KENWORTHY
NONOXIDIZING
ANNEALING FURNACES



36"x15'-0" WIRE ANNEALING FURNACE, 390 KW. CONNECTED LOAD
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Eliminate Unnecessary Operations in Heat Treating

No pickling or cleaning of wire annealed in this electric NON-OXIDIZING furnace!

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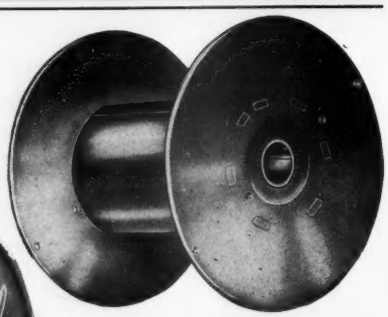

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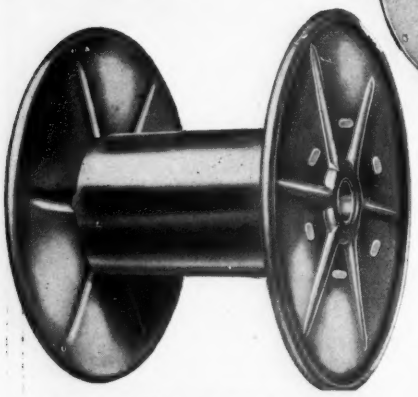

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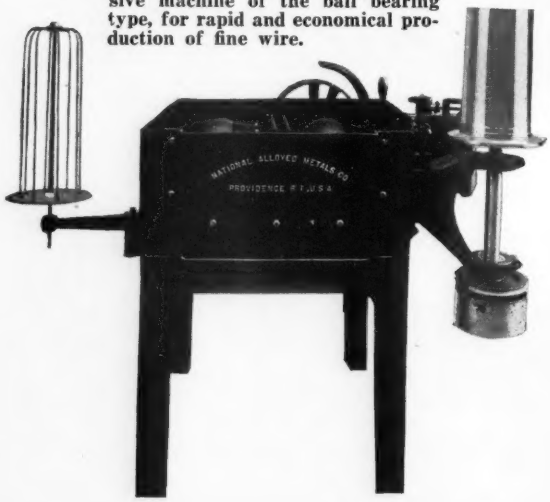


Illustration features No. 2 Machine. Capacity No. 20 B & S to .003.

We will furnish information on other sizes.

National Alloyed Metals Co.

69 Sprague St. Providence, R. I.

Alternating Torsion of Rope Wire

(*Continued from page 94*)

many important considerations beside the breaking load, and these are familiar to all engineers. A high breaking load, however, usually inspires confidence, whether merited or not. The writer made a few further tests on the M. III group of wires to show how a high tensile strength may be got from a steel in a completely fractured condition. Table V. shows the results obtained.

TABLE V—*Tension Tests of Rope Wire after being Torsioned to Fracture.*

No.	Percentage of Original Strength.
1	64.5
2	81.5
3	75.3
4	59.4
5	80.3
6	74.9
7	60.3
8	64.5
9	53.2
10	—
11	79.0
12	71.0
13	92.5
15	61.0
14	66.9

These steel wires, after being utterly crippled, and in fact in a state almost crumbling to pieces, have an apparent tensile strengths little less than three-quarters of their original values. The apparent stresses range roughly from 55 tons to 95 tons per square inch. Such figures thrown a further light on the difficulty as to why ropes, though apparently strong, may yet fracture unexpectedly.

For purposes of comparison the specimens broken in alternating torsion were thereafter tested in tension to see what percentage they would give of their original strength. The values found are given in Table VI, the average percentage being nearly 97.

TABLE VI.—*Tension Tests of Rope Wire after being Broken in Alternating Torsion, showing Percentages of Original Strength.*

No.	Percentage of Original Strength
1	98.0
2	—
3	96.5
4	99.0
5	96.5
6	96.3
7	97.5
8	100.0
9	97.0
10	99.5
11	88.0
12	97.5
13	95.0
14	99.7
15	97.3

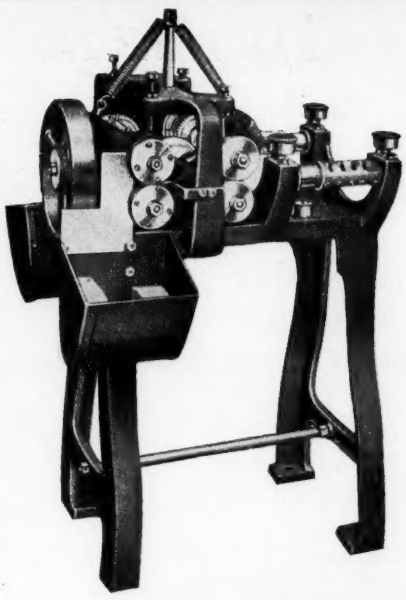
The reason for these high values is, of course, due to the fact that the breaking up of the material occurs at the region of fracture and the remainder of the specimen is not greatly damaged.

Reprinted from Engineering, Dec. 22, 1922.

Reduction in Amount of Wire in Telephone Work

IN the telephone exchange plant braid-covered rubber-insulated pairs of copper wires are used to connect the subscriber's premises with the terminals of the paper-insulated block cable or open-wire line. For many years 14-gage rubber-covered twisted pair was employed. This was followed by more economical types and recently a further reduction in the cost has been effected by the use of two 17-gage bronze wires laid parallel under a common braid. The reduction in the amount of material effected will be seen to be important when it is understood that the purchases of this type of wire in the Bell system alone aggregate more than $5,000,000 in a year.

CONTRACTS are about to close for additional shearing and straightening machinery to be used in an extension to the Medford, Mass., plant of the Northern Steel Co. of Boston.



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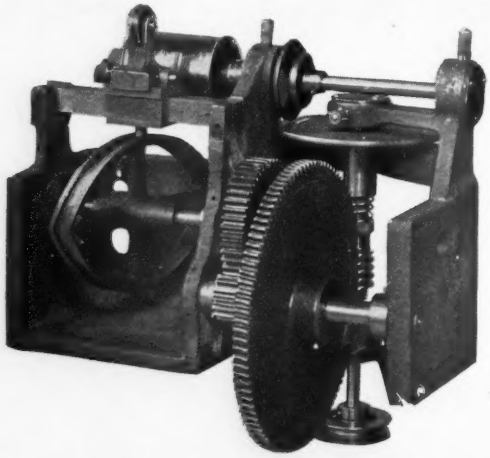

The above illustration shows an open view of our No. 1 Spooler. All gears are enclosed.

Uniform tension and lay of the wire on the Spool is assured by the use of a screw cam. It is inexpensive, simple to operate and can quickly be attached to any machine.

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NEWS of the INDUSTRY

THE Harris Alloys, Inc., the National Alloyed Metals Company and the Murray-Harris Wire Company have recently consolidated and hereafter the business of these companies will be conducted under the name of the National-Harris Wire Company.

All obligations of the Harris Alloys, Inc., the National Alloyed Metals Co. and the Murray-Harris Co. will be assumed by the National-Harris Wire Co.

THE cut steel nail manufacturing business of the Tremont Nail Co., Wareham, Mass., has been taken over by the Eastearn Nail Co., Inc., Providence, R. I., who contemplate increasing their output.

A CONCENTRATION is planned by the Torrington Company, Torrington, Conn., makers of steel needles and the like. They will discontinue their plant at Manchester, N. H., and remove their machinery to the main works at Torrington.

WARING Wire Company, Muskegon, has more orders ahead than it had last year, with very good prospects for business and has added 10,000 square feet of manufacturing space to what it used last year.

Rockford, Ill., Can and Wire Concern Bankrupt.

LISTING liabilities in the sum of $77,778.74 and assets of $54,926.22, the Roseland Can and Wire Company, Rockford, Ill., has filed a petition of voluntary bankruptcy in Federal Court here. Assets listed include tools and machinery valued at $15,000 and stock in trade valued at $10,000.

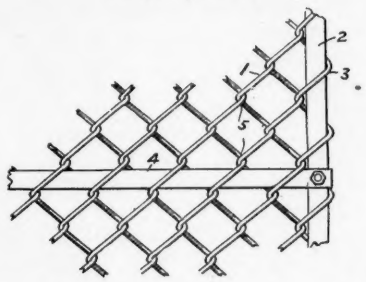
From St. Louis (Mo.) Globe-Democrat

A ONE-STORY addition costing close to $100,000 when equipped is planned by the Standard Steel Co., Coraopolis, Pa.

Review of Patents

Conducted by Eugene Grunstein

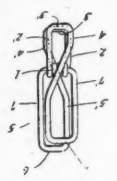
Window Guard



This window-guard consists of woven chain link wire mesh. Bars are arranged through the openings provided in the marginal chain links of the mesh. Spreaders are interposed between these bars and pass similarly through the links. The whole constitutes a portable unit construction.

U. S. Patent 1,611,384 issued to Stanley L. Sellers, Philadelphia, Pa. Dec. 28, 1926.

Wire Clothespin



An ingenious adaptation of wire to a use in which wood has heretofore been prevalent. The pin here shown is spring actuated and opens like a pair of scissors. To be effective the wire must be of a material that will not stain the clothes.

U. S. Patent 1,612,297 issued to Clifford Linpright, Marysville, Wash.

Noiseless Spring

In a spring member, a close coiled helical spring having a soft sponge rubber core conforming to the contour of the interior of the spring and vulcanized thereto, said core reducing or deadening noise and eliminating vibration of sympathetic nature or that might be produced by striking the spring or parts to which the spring is connected.

U. S. Patent 1,610,770 issued to C. W. Greene, assignor to W. G. Nagel Electric Co., Toledo, Ohio.

Patent Law for the Layman.

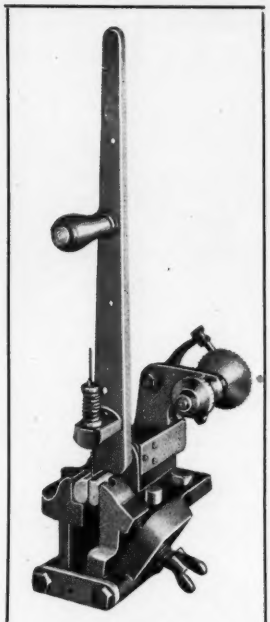
Patents. By Roger Sherman Hoar M. A., LLB. 232 pages. The Ronald Press Company, New York, 1926.

This book written especially for business executives who desire to obtain the fundamentals of Patent Law, contains enough information about Patents, Patent Law and Patent Office Procedure to enable them to understand the complexities of our Patent System.

It also contains an outline of Patent laws of foreign countries.

Much of the mystery that shrouds Patent Law in the eyes of the uninitiated is clarified by Mr. Hoar in presenting the subjects stripped of the obscuring terminology that usually envelopes technical treatises on Patents.

It is a book that will be readily appreciated not only by the busy executive, who does not have the time for an extensive study of the subject, but



Amsler's Wire Ductility Tester

The "Usefulness" of Wire in the Manufacture of Wire Products depends in Most Cases upon its "Ductility"

The best apparatus for investigating the ductility of round and flat wire, ferrous and non-ferrous, is the "Amsler Reversed Bending Tester" illustrated above.

This apparatus gives very valuable information. It can be operated by any intelligent man in the shop and it is inexpensive.

Every wire forming shop should be equipped with this handy, practical wire tester. Some plants are using a number of them in different departments.

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The above illustration covers one of many different types and sizes of Olsen Wire Extensometers for use in accurately determining the elastic limit of the wire, and the modulus, should it be desired.

The accurate elastic limit or modulus, can only be determined from instruments attached directly to the wire, and elongation only accurately determined by means of Special Olsen Elongation Scale attached to the wire, or, in the case of an Autographic Machine, by measuring the elongation autographically directly from set points on the wire.

Olsen Autographic Wire Testers measure elongation accurately directly from the wire itself and not from the motion of the parts of the machine.
For complete data as to Olsen Wire Testing Equipment, write for catalog No. 10 part "E" on "Olsen Wire Testing Machines."

To eliminate vibration and speed up production, all rotating parts should be accurately balanced statically and dynamically. This can be accomplished with accuracy, ease and despatch by using Olsen Static-Dynamic Balancing Equipment.
Full information as to this equipment will be mailed on request.

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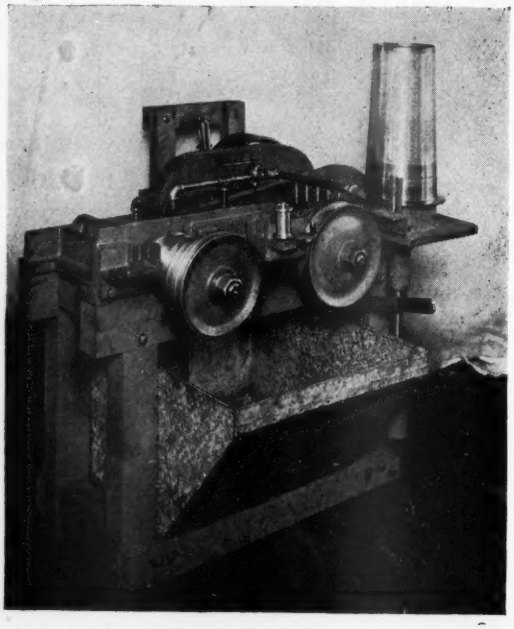
The "Superior" Wire Drawing Machine



The ultimate in a compact and inexpensive machine.

One man efficiently operates 6 of these machines simultaneously.

6-Draft Type
Floor Space 39"x54"
Capacity .032" to .004"

Designed and Manufactured by

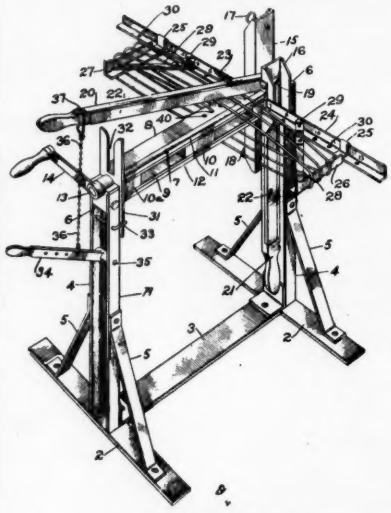
The Superior Tool & Mfg. Co.
172 UNION ST. WORCESTER, MASS.
Designers and Builders of Wire Drawing and Special Machinery

also by the inventor, the layman who is interested in this field, and wants this information in a simple authoritative and concise treatment.

A list of the eighteen chapters will show the utility of the book:

I. What is a Patent? II. What is Patentable? III. Anticipation and Domination. IV. Who is entitled to a Patent? V. Infringement. VI. Patent Office Procedure. VII. Patent Office tactics. VIII. Interferences. IX. Protecting an Invention. X. Conflicting Rights. XII. The Choice of an Attorney. XII. Legal Papers. XIII. Searches. XIV. Interpretation and Validity. XV. Organizing a Patent Department. XVI. Forms of Patent Contracts. XVII. Foreign Patents. XVIII. Misconceptions summarized.

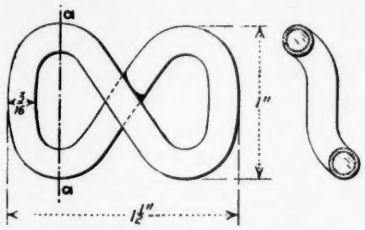
Wire Cutter and Bender



In the construction of concrete buildings a great amount of wire is required. The usual practice is to cut and bend the wire by hand as it is required. The object of the present invention is to do away with the hand-cutting and bending as much as possible by providing a machine whereby the wire may be rapidly bent into suitable shapes and cut into lengths as required.

U. S. Patent 1,589,456 issued to P. Beghetti, San Franvisco, Cal.

Tire Chains Selected by Service Trials



Tire Chain Link for Heavy Traffic
A link of tire chain that has proved to be well suited for heavy city bus travel. It is a half-twisted link, heat-treated, tough, and showing on a fractured area about $\frac{1}{8}$ in. hardness treatment. The tensile strength of this link is more than 1 ton.

STRENGTH of chain links, the degree of heat treatment of the metal of which a link is composed, and the link size are not the only considerations which enter into the selection of a suitable tire chain for use on motor buses in the opinion of Donald Mackay, supervisor of bus equipment Boston Elevated Railway. Other features which are of prime importance are the twist and number of links, the ability to resist abrasion and shock, and length. Through service tests on tires, over measured runs and under exacting weather conditions, the suitability of tire chains for use in heavy traffic and on hard pavements can best be determined. Such a procedure was followed by this company in selecting tire chains for its buses.

As the result of a series of exhaustive tests on several types of tire chain one having a coil diameter of 9/32 in. and link dimensions of 1½ in. x 1 in. was chosen. This link has about a half twist and the total length of chain required for a 36x6 or a 32x4 tire is 21¼ in. between hooks.

In the trials made with tire chains and from past experience it has been found advisable to eliminate chain spreaders. By using thirteen tie sections sufficient security is obtained and much trouble due to loose and broken spreaders eliminated, the latter often resulting in serious difficulties owing to the danger of entanglement with brake and running equipment. The experiments conducted by this company covered trials which extended over a year.

Reprinted from Elect. Railway Jl. Dec. 19, 1925.

Editorial

(*Continued from page 92*)

method by one of the largest wire manufacturers in the country has proved its effectiveness beyond doubt. Prestige, which is the aim of institutional advertising, is of course a desideratum of all manufacturers, but such advertising cannot extend the use of the product. And it has been shown that it is possible for a wire manufacturer to advertise without resorting to the comparatively passive institutional advertising.

English Wire Industry in 1592

(*Continued from page 89*)

olde and poore souldiors that are maymed in the warres and have loste both their legges and one of their armes, and so be fitt for no other woorke maye in a few hours be made able to gette an honest and competente living thereby."

(From "The Wire Drawing Industry" by K. B. Lewis)

Rod Cleaning and Coating

(*Continued from page 83*)

amount to be added for light or heavy coating depends upon local conditions, keeping in mind that the value of the lime depends upon its ability to stick to the wire, and not upon the quantity on the floor for the sweeper to remove. Various additions such as sugar and glue are used at some mills to enhance the sticking quality.

After a time, depending upon rate of use and thoroughness of washing, the lime tub becomes contaminated with iron salts, and must be dumped and refilled

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and ask us to solve their problem. Thus we designed and made the first Testing Machine. It was crude but served the purpose, and after that the engineering profession continued to

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to solve their testing problems, until now we make over a thousand different machines and appliances to meet the countless needs of the physical testing field. If you are contemplating purchasing a Testing Machine, or desire catalogues and information

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and know that we will give the same satisfactory service to you as we did back in 1866 to S. Fulton and Company.

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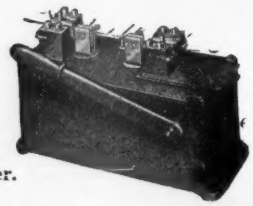

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No. 1 machine—Capacity up to No. 12 wire.
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No. 3 machine—Capacity up to ⅝" diameter.
(Wire gauge—W & M standard)

Operates on either 110 or 220 volts, single phase alternating current.
Particularly adapted to shaped wires.

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the same as an acid vat. This time will vary from two weeks to six months, and a definite record of renewals should be kept by the foreman for reference in case of trouble. This will eventually determine the safe length of service for the bath.

Various "fancy" flour and meal coats are used for special purposes, but these are a study in themselves, and are fast passing into history. There has recently been introduced a dried slacked lime, air floated, for which great results are claimed by the avoidance of all grit and foreign matter. We have not as yet however, seen any authenticated reports of its performance.

Sulling

Sulling, otherwise called "greening", and "rust coating", as before mentioned, is the production of a hydrated oxide on the surface of the rod before lime coating. This is accomplished by allowing a fine mist or spray of water to play on the rods after cleaning and washing. Care must be taken not to allow the rods to become dry, as a dry sull is certain cause for cutting out. A heavy sull, and a heavy lime coat will enable four or five drafts to be taken with ease, the resulting finish being a pleasing brownish color with almost a mirror polish. This may be used for a special finish on one and two draft work, but is not necessary from a wire drawing standpoint.

Cold Acid Cleaning

This is a practice adopted from the English, with whom muriatic is a by-product as sulphuric is with us. The certain advantages for high carbons have led to its adoption in this country. The sull obtained from a cold acid cleaning is more "greasy", and the surface action being more mild produces a smoother wire. The embrittling effect of the acid is present, however, and rods must be just as carefully baked as with sulphuric cleaning.

In cold acid cleaning the rods or wire are boxed and pinned as usual and then immersed in a solution of about 10% muriatic

acid for a half to three quarters of an hour. The temperature is not increased by outside means except in cold weather and the acid will run from 100°-120° F. depending upon conditions. After the scale is removed, the rods are washed, sulled, coated, and baked as usual.

Muriatic acid, being a gas dissolved in water, unlike sulphuric acid, will volatilize at a comparatively low temperature, and therefore cannot be used at the temperatures common for sulphuric acid. "Cold acid" is therefore a necessity from a hygienic and chemical standpoint rather than for any other reason, as the cleaning action would of course, be sharper at the higher temperatures.

So then, it makes little difference whether cold acid or hot acid be used, whether the tubs be round, square or oval, if rods are clean (there is no such thing as a poorly cleaned rod, they simply are clean or dirty) they will draw, if not, there is no department of his mill in which a Superintendent will have more trouble or lose more money than in the Cleaning House. The two places for him to sit are on the scrap pile and in the Cleaning House, and he will find the causes of the former largely eliminated by good practice in the latter.

Acid Testing Solution

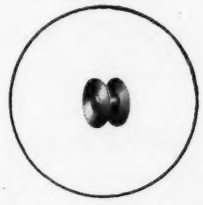
Dissolve 2 lbs. 5.7 oz. of "C. P. Dried Sodium Carbonate" in 5 gallons of water. This is equivalent to 56.5 grams Na_2CO_3 per liter.

Make a standard solution of sulphuric acid by weighing exactly 52.854 grams of 1.84 sp. gr. C. P. acid into a breaker, and making up to 500 CC in a graduated flask. This gives a standard ten percent H_2SO_4 solution.

To standarize the carbonate solution, fill a graduated 50 cc burette and read the level of the solution. Take 5 cc of the standard acid solution in a pipette, discharge into a beaker or tumbler and add 50 to 100 cc of water and 2 to 4 drops of methyl orange.

Titrate the acid solution by

2½ INCHES *or* 8 FEET



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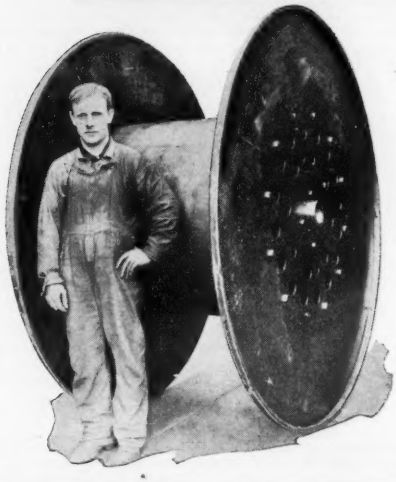

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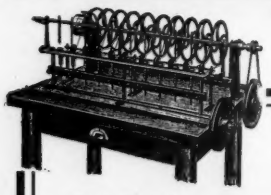

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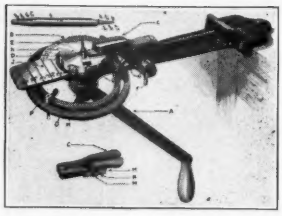

Patented April 2, 1918

M. D. Kilmer & Co. Cleveland, Ohio, U. S. A
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EST. 1855 AIMCO INC. 1915

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REG. U.S. PAT. OFF.

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ENAMELING MACHINE
(Heavy Model)
For Wire 10 to 20 B. & S. Gauge.

running the carbonate solution gradually into the acid until the red color of the methyl orange changes to yellow. This change takes place abruptly and may be made by one or two drops of the carbonate. Then read the burette. This should show that 10 cc of carbonate have been used. If this is not accurate the carbonate must be balanced either by adding water if too strong, or carbonate if too weak. Some balancing is necessary as the carbonate will vary in water of crystallization even if dried.

To test the acid vat, dip out a sample in any convenient container—usually a set of glass vials in a carrier, so that samples may be taken from all the vats at a crane—and take to the testing room. Five cc of the cleaning solution are drawn out in a 5 cc. pipette, discharged into a tumbler of water, and are titrated with methyl orange as an indicator, the same as when standardizing the solution. The number of cc. of carbonate used represents directly the percent of H_2SO_4 by weight contained in the cleaning vat.

Annealing Temp. of Copper Wire

(*Continued from page 81*)

when the wire anneals. The maximum, 101.15 per cent. in the particular material used, comes at 500° C.; thereafter the conductivity falls to 100.53 per cent. after 950° C. annealing, a drop of 0 62 per cent.

The particular interest in these figures is that similar experiments, made in 1910, also showed a maximum after a 500° C. anneal, but the drop caused by annealing at 950° C. was 2.45 per cent., being much greater than found in the present investigation. The earlier material was probably gassed at the high annealing temperatures, for the heating was done in a mild steel bomb filled with steam; the steam might readily have been decomposed, forming hydrogen, which would have penetrated the copper and caused gassing.

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In the present experiment the container was copper, not iron, and the absence of reducing gases was assured. Microscopical examination proved that no gassing had occurred in this instance.

What's New in Wire Making

(*Continued from page 89*)

The which ordinance of John Euerden then mayor seen and understood leet come before him and his Council Certain persons of the said Craft of wiredrawers, whose names follow hereafter that is to say:—
John Brien, Tho Elderbek, etc.

The wich persons above written, the ordinances above written to them read, the said ordinances so to keep agreed on, and for as much as John Stafford, Joh Blakeman, Sen., Tho Elderbok, John Sheldon the younger, and Tho. Stafford and Ric. ffilippes and Wal Bonde heldon for the most part as well Smithing, Braking. middling and cardwiredrawing, they afore the Mayor agreed on and granted to occupy their craft as hereafter followeth:—

That is to say, John Stafford granted to occupy the craft of smithing and braking John Sheldon the younger the same, John Blakeman the same, John Sheldon the elder, Ric. ffilippes. Wal Bonde, Hen. Hethe, Pet. Milner, Tho. Smyth, Tho. Stafford the same; and to leave and not occupy neither cardwiredrawing, nor girdle; and Tho. Elderbek and all these other granted to occupy cardwiredrawing and girdle, and neither smithing nor braking.

The writer is indebted to Dr. Percy Longmuir of Wortley (home of the wortle) Sheffield, England, for the foregoing account, which forms a part of the "Coventry Leet Book or Mayor's Register 1420—1555," a collection of papers edited for the Early English Text Society by Miss Mary Dormer Harris.

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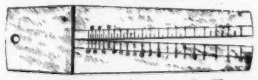
Wire Gauges



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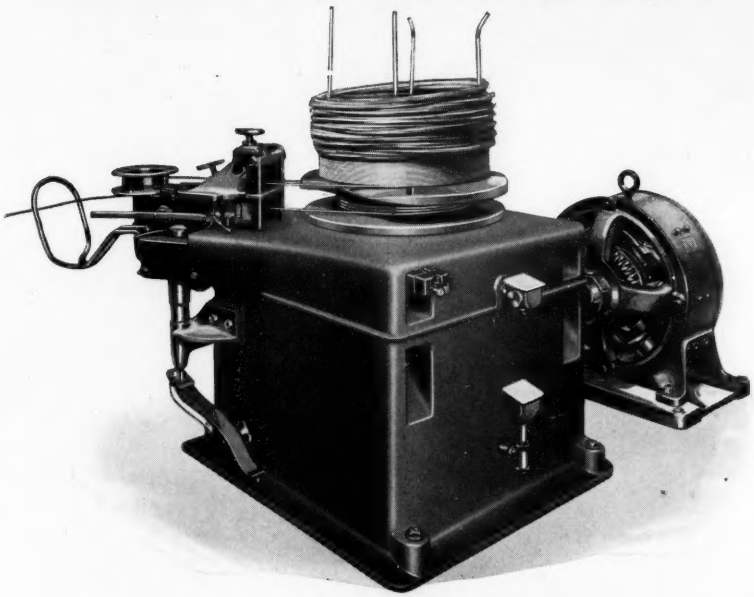

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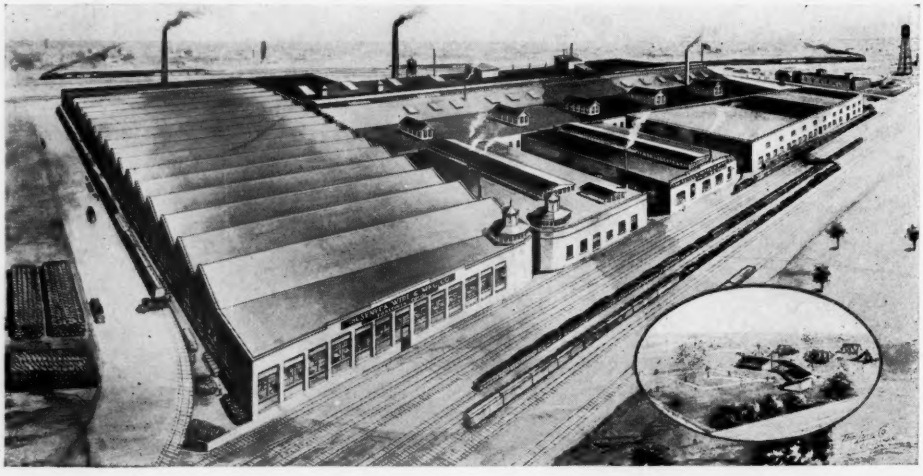

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